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COMMITTEE ON THE PEACEFUL USES
OF OUTER SPACE

THE ROLE OF THE COMMITTEE ON THE PEACEFUL USES OF OUTER SPACE IN IMPLEMENTING THE RECOMMENDATIONS OF THE UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT

Report by the Secretariat

CONTENTS

	Paragraphs	Page
INTRODUCTION	1 - 6	3
I. THE UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT	7 - 21	4
A. Organization and outcome of the Conference	7 - 14	4
1. Agenda 21	9 - 10	4
2. Rio Declaration on Environment and Development	11	5
3. Framework Convention on Climate Change	12	5
4. Convention on Biological Diversity	13	5
5. Forest Principles	14	6
B. Financial and organizational arrangements	15 - 21	6
II. AGENDA 21 AND SPACE TECHNOLOGY	22 - 78	7
A. Protection of the atmosphere	30 - 37	9
B. Integrated planning and management of land resources	38 - 43	11
C. Combating deforestation	44 - 48	12

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CONTENTS (continued)

		Paragraphs	Page
D.	Combating desertification and drought	49 - 53	12
E.	Sustainable agriculture and rural development	54 - 59	13
F.	Protection of oceans, coastal areas and marine resources	60 - 69	14
G.	Protection, development and management of freshwater resources	70 - 75	16
H.	Science for sustainable development	76 - 78	17
III.	ROLE OF THE COMMITTEE ON THE PEACEFUL USES OF OUTER SPACE AND THE OFFICE FOR OUTER SPACE AFFAIRS	79 - 119	18
A.	United Nations Programme on Space Applications ...	80 - 99	18
1.	Training courses, workshops and seminars	85 - 89	19
2.	Fellowships for advanced education	90 - 91	21
3.	Technical advisory services	92 - 93	22
4.	Centres for space science and technology education	94 - 99	22
B.	International Space Information Service	100 - 105	23
C.	Coordinating environmental space activities	106 - 109	25
D.	Policy-making for the space environment	110 - 111	26
E.	Bilateral, regional and multilateral cooperation .	112 - 119	26
1.	Planning and coordination of environmental satellites	113 - 114	26
2.	Facilitating access to data	115	27
3.	Pilot applications projects	116 - 117	27
4.	Information	118	28
5.	Technical assistance	119	28

INTRODUCTION

1. The Committee on the Peaceful Uses of Outer Space, at its thirty-fifth session,

> "agreed that the Secretariat should prepare, for the Committee's next session, an analytical report on the role that the Committee could play in view of the decisions and recommendations of the United Nations Conference on Environment and Development". 1/

The report on the session further states, in paragraph 154:

> "The Committee recognized the unique opportunity for the Committee to play an active role, where possible, in implementing relevant recommendations of the United Nations Conference on Environment and Development and invited Member States to submit their views in time before the next session of the Committee for inclusion in the report to be prepared by the Secretariat pursuant to paragraph 103 above."

2. The Secretariat sent an aide-mémoire to Member States calling their attention to that invitation. Responses were received from Austria, Colombia, Cuba, Indonesia, the Russian Federation, Senegal and Ukraine. Those responses have been used in the preparation of the present report.

3. The purpose of the present report is (a) to review the decisions and recommendations of the United Nations Conference on Environment and Development, particularly those in Agenda 21, and identify areas where space technology could contribute, and (b) to examine possible ways in which the Committee on the Peaceful Uses of Outer Space could promote the application of space technology for environmental protection and sustainable development.

4. A variety of programmes relating to space applications for environmental protection and economic development exist within the United Nations system and other international space programmes, and many of those programmes will certainly address recommendations contained in Agenda 21. However, because consideration of the role of various organizations and bodies in the implementation of Agenda 21 is now under way, it is not yet possible to present a general review of space activities relating to Agenda 21 throughout the United Nations system. Additional information on the space-related programmes of the United Nations and other international organizations, including programmes of relevance to Agenda 21, can be found in document A/AC.105/521, "Space activities of the United Nations and international organizations", and in the annual reports on coordination of space activities within the United Nations system, the most recent of which is document A/AC.105/524.

5. In accordance with the request from the Committee, and bearing in mind that the responses of the various agencies of the United Nations system to Agenda 21 are only now being formulated, the present report focuses on the work of the Committee and the activities undertaken by the Office for Outer Space Affairs at the direction of the Committee. The report focuses particularly on the United Nations Programme on Space Applications, which provides the most direct means by which the Committee can promote the use of space technology for environmental

protection and sustainable development. Consideration is also given to other international and national space activities through which the Member States in the Committee could contribute to the implementation of Agenda 21.

6. It should be noted that general responsibility for monitoring progress in the implementation of Agenda 21 and activities related to the integration of environmental and developmental goals throughout the United Nations system has been assigned by the General Assembly to the Commission on Sustainable Development, established in February 1993 by the Economic and Social Council on the recommendation of the General Assembly. One of the functions of the Commission is to analyse and evaluate reports from all relevant organs, organizations, programmes and institutions of the United Nations system dealing with various issues of environment and development and to provide appropriate recommendations to the General Assembly. The Committee may therefore wish to submit its views on the role that it can play in the implementation of Agenda 21 to the Commission on Sustainable Development.

I. THE UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT

A. Organization and outcome of the Conference

7. The United Nations Conference on Environment and Development was held from 3 to 14 June 1992 at Rio de Janeiro, Brazil, in accordance with a decision of the General Assembly, which outlined the objectives of the Conference. The report of the Conference is contained in document A/CONF.151/26/Rev.1 (vol. I and II). 2/

8. The Conference adopted three major texts: (a) Agenda 21, a comprehensive programme for global action in all areas of sustainable development; (b) the Rio Declaration on Environment and Development, a set of principles defining the rights and responsibilities of States; and (c) a set of principles on the management, conservation and sustainable development of forests. In addition, two international legal conventions were opened for signature at the Conference: the United Nations Framework Convention on Climate Change and the United Nations Convention on Biological Diversity.

1. Agenda 21

9. Agenda 21 contains the detailed considerations, conclusions and recommendations adopted by the Conference, divided into four general sections: section I on social and economic dimensions, including such factors as poverty, consumption patterns, demographic change, health and housing; section II on the conservation and management of natural resources, including land, water and marine resources and the problems of deforestation, desertification and waste management; section III on the roles of major social groups, including women, children, indigenous people, Governments and non-governmental organizations, industry and workers; and section IV on financial, institutional and technological arrangements for implementing Agenda 21. It is a comprehensive plan of action for the sustainable development of the Earth's resources, encompassing virtually all aspects of the environment and economic development. Agenda 21 is contained in annex II to document A/CONF.151/26/Rev.1 (vol. I).

10. Agenda 21 contains, within the four sections indicated above, a total of 35 chapters on substantive themes, and those chapters contain some 114 specific programmes covering all aspects of environment and development. For each of those programmes, Agenda 21 defines the basis for action, the objectives, the activities and the financial and other means required for their implementation. The programmes include activities at the national, regional and international levels.

2. Rio Declaration on Environment and Development

11. The Rio Declaration on Environment and Development is a set of 27 principles outlining the rights and responsibilities of States. The principles include the concept that the polluter must bear the cost of pollution; that States have the right to exploit their own resources but must not cause damage to the environment of other States and areas beyond their jurisdiction; that States should reduce and eliminate unsustainable consumption patterns; and that the lack of firm scientific evidence should not preclude States from taking measures to prevent environmental degradation. The Rio Declaration is contained in annex I to document A/CONF.151/26/Rev.1 (vol. I).

3. Framework Convention on Climate Change

12. The United Nations Framework Convention on Climate Change was elaborated by the Intergovernmental Negotiating Committee for a Framework Convention on Climate Change established in 1991 in accordance with a decision of the General Assembly. The Convention was completed in May 1992 and was opened for signature at the Conference. It has been signed by 161 countries and ratified by 11 (as of 22 March 1993) and will enter into force 90 days after ratification by 50 countries. It contains 26 articles, and specifies that its objective is to stabilize the levels of greenhouse gases in the atmosphere in order to prevent dangerous anthropogenic interference with the climate system. Parties to the Convention agree to reduce emissions of these gases to "earlier levels", and the Convention provides a voluntary target of reducing emissions to 1990 levels by the year 2000.

4. Convention on Biological Diversity

13. The Convention on Biological Diversity was negotiated by the Intergovernmental Negotiating Committee for a Convention on Biological Diversity established by the United Nations Environment Programme (UNEP). It was opened for signature at the Conference and has been signed by 162 countries (as of 22 March 1993). It has been ratified by 11 countries and will enter into force 90 days after it has been ratified by 30 countries. It contains 42 articles and is intended to ensure effective international action to halt the destruction of biological species, habitats and ecosystems. It requires signatories to institute measures to conserve their biological resources; imposes legal responsibility upon countries for the environmental damages caused by foreign subsidiaries of their corporations; and imposes regulations on the biotechnology industry.

5. Forest Principles

14. At the start of the preparations for the Conference, it was hoped that a convention on management and conservation of forests could be adopted by the Conference together with the conventions on climate change and biodiversity. However, it was not possible to reach agreement on a legally binding convention in time for the Conference. As a basis for subsequent negotiations towards an international agreement on forests, the Conference adopted a "non-legally binding authoritative statement of principles for a global consensus on the management, conservation and sustainable development of all types of forests". The statement includes 15 "principles/elements", including provisions that all countries should institute forest conservation and reforestation policies; that countries have the right to develop their forest resources according to their own socio-economic needs; and that financial resources should be provided to developing countries to establish forest conservation programmes. The Forest Principles are contained in annex III to document A/CONF.151/26/Rev.1 (vol. I).

B. Financial and organizational arrangements

15. The secretariat of the Conference estimated that for the period 1993-2000, the average annual costs of implementing the activities in Agenda 21 in developing countries would be over $600 billion, including about $125 billion on grant or concessional terms from the international community. It should be noted that the current total of official development assistance to developing countries is about $55 billion per year.

16. The Conference concluded that, in general, the financing for the implementation of Agenda 21 programmes would be from the public and private sectors of the individual countries concerned. The Conference also recognized, however, that for developing countries, particularly the least developed countries, new and additional financial assistance in the form of grants or other concessional financing would be required for the adoption of sustainable development practices. The Conference identified a number of sources of such financial assistance, including multilateral development banks and funds, the United Nations and its specialized agencies, bilateral assistance programmes, non-governmental financial assistance and international investment.

17. Within the United Nations system, the Global Environment Facility (GEF), a joint programme of the World Bank, the United Nations Development Programme (UNDP) and UNEP, will be the major funding mechanism for environmental protection and sustainable development projects. Some additional funding could be forthcoming through the World Bank's International Development Association (IDA), which provides loans on concessional terms to developing countries, and from a portion of the Bank's net annual income which would be allocated to an "Earth increment" for the funding of national environmental programmes. The new UNDP "Capacity 21" initiative would also assist in building national capacities for implementing Agenda 21, with a focus on human resources training, institution-building and exchange of environmentally sound technologies.

18. The General Assembly, in its resolution 47/190 of 22 December 1992, endorsed Agenda 21, the Rio Declaration and the Forest Principles and urged Governments, organs, organizations and programmes of the United Nations system

as well as other intergovernmental and non-governmental organizations to take the necessary action to give effective follow-up to those documents. The Assembly took note of the initial financial commitments made by some developed countries and urged those countries which have not done so to announce their commitments. The Assembly also decided to convene, not later than 1997, a special session for the purpose of an overall review and appraisal of Agenda 21.

19. The General Assembly, in resolution 47/191 of 22 December 1992, endorsed the recommendations in Agenda 21 concerning international institutional arrangements to follow up the Conference and requested the Economic and Social Council to establish the proposed high-level Commission on Sustainable Development as recommended in Agenda 21. One of the functions of the Commission would be to monitor progress in the implementation of Agenda 21 and related activities throughout the United Nations system through analysis and evaluation of reports from all relevant organs, organizations, programmes and institutions of the United Nations system. The Assembly also recommended that the Commission actively interact with other intergovernmental United Nations bodies dealing with matters related to environment and development.

20. The Commission on Sustainable Development, with 53 member States, was established by the Economic and Social Council and held a brief organizational meeting in February 1993. The first substantive meeting of the Commission is to be held in June 1993.

21. The General Assembly, in resolution 47/191, took note of the decision of the Secretary-General to establish a new Department for Policy Coordination and Sustainable Development. That Department, which is now in the process of being created as part of the restructuring of the Secretariat, would have the primary responsibility for coordinating the work of the Secretariat to follow up the Conference and to service the Commission on Sustainable Development.

II. AGENDA 21 AND SPACE TECHNOLOGY

22. The focus of Agenda 21 is on practical action that needs to be taken on the ground to protect the environment and promote sustainable development. In support of that effort, consideration is also given to the need for studying and monitoring the environment on a continuing basis. In a number of areas, including land-use planning and management, deforestation, desertification, water resource assessment and scientific study of environmental dynamics, Agenda 21 specifically recognizes the important contribution that space technology can make to environmental monitoring and sustainable development. In many other areas, Agenda 21 calls for expanded and improved environmental monitoring, data collection and resource survey activities in which space technology can play an important role.

23. The space technologies of interest with respect to Agenda 21 are primarily Earth observation technologies, including both remote sensing of the environment and natural resources and meteorological and climatic observations of the surface and atmosphere. Communication satellites, broadcasting satellites, navigation satellites, search and rescue satellites and other space systems can also contribute in more indirect ways to the goals of Agenda 21. It should be noted in particular that satellite communication systems can play a vital role

in the collection of environmental data and distribution of information, especially when rapid action is required, for example in cases of severe storms, for crop and rangeland management and for surface water management. The applications of communication satellites and other non-Earth-observation satellites, however, are not directly addressed in Agenda 21 and will not be considered in the present report. A detailed study of the applications of space technology for remote and rural communications and broadcasting, prepared by the Secretariat at the request of the Scientific and Technical Subcommittee, is contained in document A/AC.105/536.

24. For detailed observations of the Earth's land surface, the satellites in widespread international use include the United States Landsat system, in operation since 1972, and the French SPOT (Satellite Pour l'Observation de la Terre) system, in operation since 1986. The current Landsat satellites provide images with 30 m resolution in seven spectral bands and with repeat coverage every 16 days. The SPOT satellites provide images with 10 m to 20 m resolution with three spectral bands and a 26-day repeat cycle. The SPOT sensor can be pointed to areas away from the subsatellite track allowing for stereoscopic coverage, greater flexibility in obtaining cloud-free coverage and more frequent coverage for selected areas. Other satellites designed for land remote sensing include the Russian Resurs satellites, the Indian Remote Sensing (IRS) satellites, and Chinese remote-sensing satellites.

25. A major advance in ocean observations has been the development of satellites carrying imaging radar systems and other microwave sensors, notably the European Remote Sensing (ERS-1) satellite launched in 1991, providing images with 30 m resolution and a normal repeat cycle of 35 days. Other satellites with microwave sensors include the United States/France Topex/Poseidon satellite, the Japanese Earth Resources Satellite (JERS-1) and the Russian Okean satellites. The Japanese Marine Observation Satellites (MOS), carrying multispectral sensors, are also designed for marine applications.

26. For operational weather observations, the main satellites in international use are the United States NOAA satellites in polar orbits, providing twice-daily coverage with 1 km resolution in visible, near infrared and thermal infrared spectral bands, and a series of geostationary satellites positioned at intervals around the equator, including the United States Geostationary Operational Environmental Satellites (GOES), the European Meteosat satellites, the Japanese Geostationary Meteorological Satellites (GMS) and the Indian Insat satellites. The geostationary satellites provide observations with 1 km to 8 km resolution as often as every 30 minutes in visible, thermal and water-vapour spectral bands. Other satellites for weather and climate observations include the Russian Meteor satellites, the United States Upper Atmosphere Research Satellite (UARS), and the Chinese Fengyun satellites. Sensors for monitoring atmospheric ozone are carried on United States and Russian meteorological satellites.

27. Compared with ground surveys, satellite observations provide less detail, but much greater economy, particularly where repetitive monitoring is required. Satellites are particularly advantageous, therefore, for regular, low-cost environmental monitoring of large areas. Large-scale phenomena or patterns that are not visible to a ground observer can often be seen on satellite images; transboundary phenomena that can be logistically difficult to survey from the ground or air offer no difficulty for space observations; environmental changes

that occur gradually over periods of years or decades can be measured from the satellite images regularly acquired by the same sensors under the same conditions; and transient atmospheric or oceanographic phenomena can be followed by daily or hourly observation by weather satellites. The remote-sensing images that have been gathered and archived since 1972 provide a unique and invaluable database for studying and documenting past, present and future environmental change.

28. Satellites cannot, of course, be used directly to prevent environmental degradation; they can merely observe the situation on the ground. Those observations can be used for a number of purposes. In the case of ocean and climate dynamics, for example, satellite observations are used to observe sea-surface temperature and current patterns in order to improve the understanding of their effect on weather patterns and predict the long-term effects of climate change. In the case of pollution, satellite images can be used to detect sources of harmful discharges into the air or water so that technical or legal action can be taken to prevent them. In the case of forestry, agriculture and rangeland, satellite data can reveal gradual degradation processes, allowing planners to develop effective policies for sustainable development. When environmental policies are adopted, satellite observations can be used to monitor the effectiveness of the policies and to revise the policies when necessary.

29. For the purposes of the present report, eight areas related to one or more of the programmes recommended in Agenda 21 have been selected as representing the most important practical applications of satellite remote-sensing technology for environmental protection and sustainable development. Given the wide scope of Agenda 21 and the large number of programmes recommended, the present report cannot comprehensively cover all of the relevant applications of space technology, but can provide an overview of the major applications.

A. Protection of the atmosphere

30. Protection of the atmospheric environment is the main subject of chapter 9 of Agenda 21 and also relates to chapter 6 on protecting and promoting human health. The study of atmospheric change and its effects on natural processes and sustainable development are the subject of programme 9.A; the monitoring of air pollution is the subject of programmes 6.E and 9.D; and monitoring of the stratospheric protective ozone layer is part of programme 9.C.

31. According to Agenda 21, the basis for action on the atmospheric environment is the growing concern about climate change and climate variability, air pollution and ozone depletion, which has created new demands for scientific, economic and social information to reduce the remaining uncertainties in these fields. Agenda 21 notes that better understanding and prediction of the various properties of the atmosphere and of the affected ecosystems, as well as health impacts and their interactions with socio-economic factors, are needed.

32. An important application of space technology relating to the atmospheric environment is indirect, through the observation of short- and long-term changes in vegetation resulting from climate change due to greenhouse gases, from acid rain or from other types of air pollution. The repetitive observations of

vegetation patterns over broad areas using meteorological or remote-sensing satellites is the most cost-effective way of observing the harmful effects of those phenomena and providing information for planning appropriate responses. Satellite applications, such as the monitoring of vegetation density using the vegetation-index technique, have proved particularly valuable in the fragile ecosystems of the semi-arid zone, where vegetation, animals and human populations are highly vulnerable to climate change. The study of the effects of climate change and adaptation to the impacts of climate change are also central objectives of the Framework Convention on Climate Change.

33. Satellites also play an essential role in monitoring the Earth's stratospheric ozone layer, which protects people and other living things from the harmful effects of the Sun's ultraviolet radiation. The Total Ozone Mapping Spectrometer, on United States and Russian meteorological satellites, and the ozone sensor on the UARS satellite have provided detailed maps of the ozone "hole" that forms over Antarctica each spring as well as information on the gradual deterioration of the ozone layer over other areas. Recent measurements by those sensors have revealed that, during early 1993, ozone levels declined to the lowest levels observed during 14 years of observations. At mid-latitudes in the northern hemisphere, ozone levels were 10 to 20 per cent below normal. It is believed that those low levels are due to the combined effects of chlorofluorocarbons (CFCs) and the 1991 eruption of the Mount Pinatubo volcano in the Philippines, which injected large amounts of dust and gas into the upper atmosphere, as revealed by meteorological satellite observations.

34. The 1987 Montreal Protocol on Substances that Deplete the Ozone Layer committed countries to phasing out the use of CFCs and other ozone-depleting substances. Satellite observations will be essential to monitoring ozone depletion, evaluating the effectiveness of the steps taken by the international community to halt that process and assessing the need for further action.

35. The use of satellites for monitoring atmospheric smoke and dust, of both natural and anthropogenic origin, is complicated by the presence of clouds, but satellite imagery nevertheless provides reasonably reliable qualitative data on particulate pollutants. Observations can be made of general levels of haze, and both meteorological and remote-sensing satellite imagery show plumes or clouds of dust or smoke from extensive natural sources and, in some cases, from industrial point sources. Satellites can be particularly useful in monitoring transboundary pollution and in assessing the effectiveness of policies for limiting air pollution.

36. Recent observations of atmospheric ozone, together with satellite observations of smoke plumes from vast areas of grass and brush fires set for seasonal agricultural clearing in the tropics, have indicated that those fires are causing high concentrations of surface-level ozone and smog in the tropics, similar to the concentrations produced at more northerly latitudes by vehicles and industrial air pollution. Those observations indicate that the health risks to humans and other organisms due to tropospheric ozone and smog are greater than previously thought and may require stronger action.

37. A detailed review of upper atmosphere studies for weather and environment monitoring, prepared by the Secretariat at the request of the Scientific and Technical Subcommittee, is contained in document A/AC.105/477.

B. Integrated planning and management of land resources

38. Land-use planning is an element of Agenda 21, chapter 7 on promoting sustainable human settlement development, and particularly of programme 7.C on promoting sustainable land-use planning and management, programme 7.D on promoting the integrated provision of environmental infrastructure: water, sanitation, drainage and solid-waste management, and programme 7.F on promoting human settlement planning and management in disaster-prone areas. In programme 7.C, Agenda 21 recommends that "all countries, particularly developing countries, ... should be given access to modern techniques of land-resource management, such as geographical information systems, satellite photography/imagery and other remote-sensing technologies" (para. 7.33).

39. Satellite observations, supplemented by ground surveys, can provide up-to-date information on regional land-use patterns. They can also provide some information on the distribution of geological structures and soil types, vegetation classes, water resources, transportation networks, urbanization, flood risk and other parameters which can be used with information from other sources to determine the suitability of land for a particular use.

40. Repetitive satellite observations have been used in many areas to monitor urbanization, particularly in the cases of rapidly expanding cities. Aerial photography, while often necessary for detailed urban mapping, is often too expensive for frequent monitoring of changes, and the high-resolution satellite data now available can meet many of the requirements of urban planners. Changes from agricultural use to urban development are easily identified on satellite images, and different types of development, such as industrial, high-density residential and commercial, and low-density residential, are generally distinguishable.

41. For planning purposes, satellite observations of soils, geological and hydrological features and natural vegetation, as well as existing agricultural, industrial, commercial and residential use, interpreted in conjunction with selective ground observations, provide a cost-effective means of identifying land most suitable for particular uses, including irrigated agriculture, pasture and forest preservation, and the expansion of urban areas. The satellite data also help locate sites for water resource development and for the transportation and communication lines needed for land development.

42. An important new tool for land-use planning and management is the computer-based geographical information system (GIS), which can integrate satellite data with data from other sources into an interactive system that provides planners and managers with customized information in visual form for effective decision-making.

43. In Central and Eastern Europe, for example, satellite remote-sensing images are being used to map land that has been degraded by activities such as open-pit coal mining, waste dumps and military facilities. The satellite images reveal large areas of degraded vegetation and soils, water and wind erosion and polluted water bodies, as well as likely areas of soil and groundwater contamination. The satellite information has been combined with information from other sources in geographic information systems, which will be used for planning land rehabilitation measures and future land use development.

C. Combating deforestation

44. Chapter 11 of Agenda 21 addresses the need to combat deforestation, and programme 11.D specifically concerns establishing and strengthening capacities for the planning, assessment and systematic observations of forests, noting the contribution of remote sensing and geographic information systems and recognizing the need for training in remote sensing (paras. 11.36 and 11.38).

45. Forest lands are often found in areas of low population density and on land unsuited to intensive agricultural development because of climate, soil or topography. Many forest areas are of relatively low economic productivity and therefore do not justify expensive ground or aerial surveys. Satellite observation is therefore the optimum method to map forest types, forest fires and infestations, and to monitor logging operations and other changes in forest areas.

46. In areas undergoing rapid deforestation, such as much of the Earth's tropical rain-forest regions, frequent satellite observation can reveal the extent and pace of deforestation. Although many satellite observations systems in use today lack the resolution for precise and highly detailed measurement of deforestation rates, they are still extremely useful because of their large coverage areas. More detailed images are also valuable for monitoring the scope and effectiveness of reforestation efforts in these areas.

47. Monitoring the global forest cover and the long-term rates of deforestation and reforestation is an essential element of the study of global climate change. Because of the vast areas to be repetitively monitored, there is a great need for low-cost automated survey techniques. The use of satellite remote sensing together with geographic information systems and other computer data processing and analysis techniques will be essential to such efforts. The small number of people in a few countries who are trained and experienced in those techniques will be a limiting factor in forest monitoring and management programmes.

48. Remote-sensing satellite data have been used in Brazil to study deforestation in the Amazon region, an example of the tropical deforestation that is thought to play an important role in global warming and the loss of biodiversity. Those studies have indicated that deforestation in the Amazon region is somewhat lower than previously estimated, but still high enough to be a matter of concern. Brazil has taken the lead in planning a World Forest Watch programme, developed in the context of International Space Year, which will include a global forest monitoring component using meteorological satellite data and a regional component using Landsat and SPOT remote-sensing data.

D. Combating desertification and drought

49. Combating desertification and drought is the subject of chapter 12 of Agenda 21. The programmes in that area include developing information and monitoring systems for regions prone to desertification and drought (programme 12.A), combating land degradation through soil conservation, afforestation and reforestation (programme 12.B) and developing drought-preparedness and drought-relief schemes (programme 12.E). Agenda 21 recognizes that world-wide systematic observation systems are essential to understanding the dynamics of

desertification and drought processes and recommends that Governments of affected countries, with the support of international and regional organizations, should strengthen national early-warning systems, with particular emphasis on risk-mapping, remote sensing, agrometeorological modelling and crop-forecasting techniques (para. 12.49 (c)).

50. Areas prone to desertification are generally semi-arid areas of low economic productivity, which therefore do not justify intensive monitoring and intervention. Even more than in forest areas, the essential requirement for desertification monitoring is for low-cost repetitive surveys. Two powerful new techniques for that purpose are the analysis of multispectral meteorological satellite data in terms of the "vegetation index", a measure of the density of green vegetation, and the use of cloud temperature data for rainfall estimation. The use of high-frequency low-resolution satellite data allows monitoring of vegetation and rainfall during each growing season for purposes of range management, drought warning and crop forecasting.

51. The processes of wind and water erosion that contribute to desertification are generally not directly visible on satellite images, but indicators of susceptibility to erosion can be mapped effectively. Water erosion generally depends on slope, soil characteristics, vegetation cover and drainage patterns, all of which can be interpreted, either directly or indirectly, from remote-sensing satellite images. From the maps of those features, a combined map of susceptibility to water erosion can be prepared for use in agricultural and land-use planning.

52. An ecological monitoring programme has been established in Senegal using satellite data supported by selective aircraft and ground observations to monitor seasonal rangeland vegetation, agricultural production, rainfall, brush fires and animal and population densities in order to improve agricultural planning and ensure sustainable use of rangeland. The use of meteorological satellite data to estimate rainfall and assess the state of vegetation every 10 days during the growing season provides good forecasts of agricultural production and warnings of agricultural failures that may require food relief.

53. A detailed review of the applications of space technology to the study of desertification in developing countries, prepared by the Secretariat at the request of the Scientific and Technical Subcommittee, is contained in document A/AC.105/501.

E. Sustainable agriculture and rural development

54. Promoting sustainable agriculture and rural development is the subject of chapter 14 of Agenda 21, including the monitoring and management of agricultural production, rangelands, forests and wildlife (programme 14.A), land-resource planning and management (programme 14.D), and land conservation and rehabilitation (programme 14.E).

55. Satellite imagery, on its own, can be used to determine the extent and location of cultivated land, and, when used in conjunction with ground sampling, it can assist in acreage and yield estimations for specific crops. Satellite imagery is also useful for tracking and predicting plant parasite infestation

and, on an experimental basis, for determining soil moisture. Multispectral vegetation monitoring techniques are also useful for qualitative crop forecasting, especially in semi-arid areas.

56. As Agenda 21 recognizes, the formulation of agricultural and rural development policies depends on reliable information on agricultural land use, availability of water, cropping patterns and schedules, soils and erosion and other land features. The integration of satellite data and data from other sources into geographic information systems can provide essential information for policy-making and planning purposes.

57. Assuring adequate supplies of clean water for human and animal consumption and agricultural irrigation is essential to rural development and poses a major problem in semi-arid and arid areas. Geological analysis of remote-sensing satellite imagery has proved very valuable in locating productive areas for groundwater development for rural water supplies. In India, satellite data together with information from other sources has been used to produce maps of groundwater potential based on drainage, topography, landforms, rock types, soils and fracture patterns. These maps have made an important contribution to the national effort to provide clean drinking water within one mile of every village and have improved the success rate in drilling wells with good yield of water from about 50 per cent to about 90 per cent, yielding substantial savings in time and money.

58. For remote and rural areas in developing countries, especially in mountainous regions (Agenda 21, chap. 13), ground information can be difficult and expensive to obtain. Satellite data for such areas can be essential for water resource development, flood control schemes, forest management and erosion control, transportation system development and other development purposes. It should also be noted that satellite communications can be very cost-effective in mountainous regions since land lines can be very difficult and expensive to construct and maintain.

59. A detailed study on the application of space technology for integrated land and water resources management for rural development, prepared by the Secretariat at the request of the Scientific and Technical Subcommittee, is contained in document A/AC.105/490.

F. Protection of oceans, coastal areas and marine resources

60. The protection of the oceans, coastal areas and marine resources is covered in chapter 17 of Agenda 21, with particular consideration given to integrated management and sustainable development of coastal and marine areas, including exclusive economic zones (programme 17.A), marine environmental protection (programme 17.B), sustainable use and conservation of living marine resources (programmes 17.C and D) and addressing the implications of climate change for marine resources and coastal areas (programme 17.E). Agenda 21 notes that coastal States should improve their capacity to collect, analyse, assess and use information for sustainable use of resources, including environmental impacts of activities affecting the coastal and marine areas (para. 17.8) and that international organizations should support coastal States in those efforts (para. 17.16).

61. The global ocean system covers approximately 75 per cent of the Earth's surface and has a major impact on all human activities and the Earth environment. The oceans are a major factor in our weather system, provide food and energy, and are essential to world commerce. They also pose hazards due to flooding and coastal erosion and spawn the hurricanes and tropical storms that cause tremendous damage to land areas.

62. To meet the requirements for marine resource monitoring and management over the vast global ocean, repetitive satellite observations are essential, together with selected local surface and depth measurements to complement and calibrate the satellite data. Information requirements that are being met by satellites include surface temperature, ocean currents and circulation, coastal dynamics, sediment transport, erosion, shoaling, surface winds, wave height and direction, and sea ice and its dynamics. Satellites provide the only cost-effective method for observation of these parameters on a continuous basis.

63. Sea-surface temperature measurements from infrared sensors on meteorological satellites are being used in a number of countries in support of fishing activities, based on the tendency of certain species of fish to remain within a certain temperature range. Thermal observations also reveal areas of upwelling of cold deep water that is rich in nutrients and supports marine productivity. While that information is used primarily to make fishing activities more efficient, it can also be used by fisheries managers to effectively monitor and manage marine resource stocks.

64. The repetitive coverage provided by high-resolution remote-sensing satellites provides an effective tool for coastal zone monitoring. A series of images over time can reveal erosion and deposition of sediments, changes in the shoreline, changes in tidal wetlands and other coastal zone vegetation, development of coastal areas and, in some cases, discharge and transport of effluent.

65. The economic productivity of the oceans can be increased on a sustainable basis through aquaculture development, which can be assisted through satellite surveys of potential sites. The use of satellites for water temperature monitoring, early warning of algae blooms and marine weather forecasting and storm warning can provide vital data for the management of aquaculture operations.

66. Oil discharges from ships, offshore production sites or coastal facilities pose a major environmental hazard to the oceans and coastal zones. Recent work with satellite radar systems has demonstrated the capability to map and monitor oil slicks from space, at least under moderate wind conditions. Large scale pollution, such as ocean sewage dumping or other effluent discharges, can sometimes be seen on multispectral satellite images.

67. Satellite radar observations have also demonstrated the capability to make shipping operations safer and more effective. Satellite measurements of sea-state, surface winds and ice cover can reduce travel time and fuel consumption, reduce the risk of accidents and allow operations in ice-infested waters. Radar data can also be used to monitor shipping operations in a country's exclusive economic zone as part of a comprehensive maritime management scheme.

68. Global climate change raises particular problems for maritime and coastal activities, as noted in Agenda 21. Sea-level changes threaten low-lying coastal areas, global warming could change weather patterns and intensify tropical storms, and deterioration of the ozone layer may have harmful effects on marine productivity. Studying and monitoring global climate change and its consequences requires regular global surveys using meteorological and remote-sensing satellites. Meteorological satellites are essential for detecting the development of severe storms over the oceans and for tracking them as they approach land. Bangladesh, for example, with extensive low-lying coastal areas susceptible to flooding and tropical cyclones, uses meteorological satellite observations to monitor the size, wind speed and direction of cyclones in the Bay of Bengal, to issue warnings for threatened areas and to assess damage following a storm.

69. A detailed review of the applications of space technology to ocean resources, prepared by the Secretariat at the request of the Scientific and Technical Subcommittee, is contained in document A/AC.105/535.

G. Protection, development and management of freshwater resources

70. Protection, development and management of the quality and supply of freshwater resources is covered in chapter 18 of Agenda 21, including integrated water resources development and management (programme 18.A), water resources assessment (programme 18.B), protection of water resources, water quality and aquatic ecosystems (programme 18.C) and the impacts of climate change on water resources (programme 18.G). Programme 13.A also notes the importance of meteorological and hydrological monitoring in mountain regions and of identifying areas subject to erosion, flooding, landslides and other hazards. Agenda 21 notes in particular the importance of remote sensing and geographic information systems for water resource assessment, flood and drought forecasting, and the collection and processing of hydrologic data (para. 18.27).

71. Management of water resources requires regular collection of information on water availability, including data on rainfall, runoff, surface storage and evaporation, much of which can be gathered in a very cost-effective manner by satellite. Meteorological satellites provide data for rainfall prediction and estimation, and remote-sensing imagery reveals the distribution of surface water and its changes with season. Similarly, satellites can help map snow cover, an important source of water at high altitudes and high latitudes.

72. In Burkina Faso, satellite images have been used to map and monitor the large number of small reservoirs that are a vital source of water for human and agricultural use during the eight-month dry season. Because most reservoirs are small earthen structures built at various times by a variety of agencies, the remote-sensing satellite images provided the first accurate and current map of all of the reservoirs. Repetitive coverage from various seasons and years indicated new dams that had recently been built and in some cases revealed dams that had broken and not been repaired. The repetitive coverage also indicates the volume of the water at various times and the time in the dry season when the stored water is normally exhausted.

73. In more humid areas where water can be excessive, repetitive satellite coverage can assist in the prediction of flooding and in flood mapping for planning and directing relief efforts. Archival information from satellite systems is essential for modelling the hydrologic behaviour of watersheds and for long-term planning of flood control and flood relief programmes.

74. Climate change, both natural and anthropogenic in origin, also affects freshwater availability, in particular through changes in rainfall distribution in space and time. Meteorological satellite data play an essential role in studying and monitoring climate change and its effect on water resources. The ongoing work of the Intergovernmental Panel on Climate Change (IPCC), the World Climate Programme (WCP) and the International Geosphere-Biosphere Programme (IGBP) are all based in part on space observations.

75. A detailed review of applications of space technology to flood monitoring and control, prepared by the Secretariat at the request of the Scientific and Technical Subcommittee, is contained in document A/AC.105/472.

H. Science for sustainable development

76. Chapter 35 of Agenda 21 recognizes the importance of science for sustainable development and notes that a better understanding of land, oceans, the atmosphere and their interlocking water, nutrient and biogeochemical cycles and energy flows is essential for a more accurate estimate of the carrying capacity of the planet Earth and that modern, effective and efficient tools, such as remote-sensing devices, are now available for those applications (para. 35.2). Agenda 21 encourages coordination of satellite missions, the networks, systems and procedures for processing and disseminating their data, and the development of interfaces with research users of Earth observation data and with the United Nations Earthwatch system (para. 35.12 (d)). It also recommends that, in order to understand the Earth as a system, space Earth-observation systems should be developed to provide integrated, continuous and long-term measurement of the interactions of the atmosphere, hydrosphere and lithosphere, and that a distribution system for data should be developed to facilitate the use of such data (para. 35.12 (h)). Agenda 21 recommends increasing the use of space-based observation technology and the development and expansion of the Global Climate Observing System (para. 35.14 (b)).

77. Finally, in chapter 40 on information for decision-making, Agenda 21 recommends that countries and international organizations should make use of new techniques of data collection, including satellite remote sensing. It also recommends that relevant international organizations should develop practical recommendations for coordinated, harmonized collection and assessment of data at the national and international levels and that national and international data and information centres should set up continuous and accurate data-collection systems and make use of geographic information systems and other data-processing techniques to handle the large quantities of data from satellite systems that will need to be processed in the future (paras. 40.8 and 40.9).

78. Agenda 21 also recommends that relevant organs and organizations of the United Nations system, in cooperation with other international governmental, intergovernmental and non-governmental organizations, should use a suitable set

of indicators related to areas outside of national jurisdiction, such as the upper atmosphere and outer space (para. 40.7).

III. ROLE OF THE COMMITTEE ON THE PEACEFUL USES OF OUTER SPACE AND THE OFFICE FOR OUTER SPACE AFFAIRS

79. A variety of agencies and offices of the United Nations system have roles to play in applying space technology for implementing the recommendations of Agenda 21. UNEP uses satellite data for environmental monitoring, the Food and Agriculture Organization of the United Nations (FAO) uses satellites for natural resource management and agricultural surveys, the Office of the United Nations Disaster Relief Coordinator (UNDRO) uses satellites for disaster warning and relief, the World Meteorological Organization (WMO) uses satellites for weather and climate studies and other organizations use space technology in their areas of work. Those agencies and offices are now in the process of developing plans for contributing to Agenda 21 programmes. Because those plans are not yet developed, the present report will focus on the activities of the Committee on the Peaceful Uses of Outer Space and the Office for Outer Space Affairs.

A. United Nations Programme on Space Applications

80. The United Nations Programme on Space Applications has, since its creation by the Committee on the Peaceful Uses of Outer Space in 1970, been the primary vehicle through which the United Nations has worked to increase the awareness on the part of policy makers and concerned government agencies of the benefits that can be derived from the applications of space technology and to organize training and education programmes to enable officials from developing countries to gain practical experience in these applications.

81. Following the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82), and taking into account the growing experience of both developed and developing countries in the practical applications of space technology, the objectives of the Programme on Space Applications were expanded to include:

(a) Promotion of greater exchange of actual experiences with specific applications;

(b) Promotion of greater cooperation in space science and technology between developed and developing countries as well as among developing countries;

(c) Development of a fellowship programme for in-depth training of space technologists and applications specialists, with the help of Member States and relevant international organizations, and establishment and regular updating of lists containing available fellowships in all States and relevant international organizations;

(d) Organization of regular seminars on advanced space applications and new system developments for managers and leaders of space application and

technology development activities as well as seminars for users in specific applications for durations as appropriate;

(e) Stimulation of the growth of indigenous nuclei and an autonomous technological base, to the extent possible, in space technology in developing countries with the cooperation of other United Nations agencies and/or Member States or members of the specialized agencies;

(f) Dissemination - through panel meetings and seminars, etc. - of information on new and advanced technology and applications, with emphasis on their relevance and implications for developing countries;

(g) Provision or arrangements for provision of technical advisory services on space applications projects, upon request by Member States or any of the specialized agencies. 3/

82. The Programme has pursued these objectives through a variety of activities, including training courses, workshops, seminars, meetings of experts, fellowships for advanced study, technical advisory services, information services and the development of regional centres for space science and technology education.

83. Financial support for the activities of the Space Applications Programme comes from the regular budget of the United Nations, from voluntary contributions by Member States, from the host countries and other sponsoring organizations for the activities and from the countries and international organizations which provide instructors and speakers for the activities. In general, most of the cost of each activity is borne by the host country or organization, in some cases with the assistance of a co-sponsoring donor country or organization. Only a small part of the total cost of the activities is covered by the regular budget allocation.

84. In the last few years, in response to the views of Member States in the Committee, to the needs expressed by developing countries, and to the offers from host countries, an increasing number of activities have focused on environmental remote sensing and other activities related to Agenda 21.

1. Training courses, workshops and seminars

85. As part of the Programme on Space Applications, the United Nations Office for Outer Space Affairs normally conducts about five to seven training courses, workshops and seminars each year on different aspects of space science, technology and applications. From 1983 through 1992, the Programme organized 58 training courses, workshops, seminars and meetings of experts of one to five weeks' duration with over 1,500 participants. Those activities focused on the needs of developing countries, with the majority of participants, and all of those who received United Nations funding for their participation, coming from developing countries.

86. The training courses, workshops and seminars have stressed the applications of space technologies for development and have included applications for

environmental management. The programme for 1993 includes the following activities:

(a) A United Nations/European Space Agency (ESA) Training Course for African Francophone Countries on the Monitoring of Natural Resources, Renewable Energy and Environment using the European Remote Sensing Satellite (ERS-1), to be organized in cooperation with the Department of Economic and Social Development and held at the European Space Research Institute (ESRIN) in Frascati, Italy, from 19 to 30 April 1993;

(b) The Third United Nations Training Course on Remote Sensing Education for Educators, to be organized in cooperation with the Government of Sweden and held at Stockholm and Kiruna from 3 May to 4 June 1993;

(c) A United Nations Workshop on Space Communications for Development, to be organized in cooperation with the Government of Greece and held at Athens from 10 to 12 May 1993;

(d) A United Nations Regional Conference on Space Technology for Sustainable Development, to be organized in cooperation with the Government of Indonesia and held at Jakarta from 17 to 21 May 1993;

(e) A United Nations/ESA Regional Workshop on Space Technology to combat Natural Disasters, to be organized in cooperation with the Government of Mexico and the Office of the United Nations Disaster Relief Coordinator (UNDRO) and held at Mexico City from 27 September to 1 October 1993;

(f) A United Nations/International Astronautical Federation (IAF) Workshop on Organizing Space Activities in Developing Countries, to be organized in cooperation with the Government of Austria and IAF and held at Graz, Austria, from 15 to 17 October 1993;

(g) A United Nations Workshop on Basic Space Science, to be organized in cooperation with the Government of Nigeria and held at Lagos from 18 to 22 October 1993;

(h) A United Nations Regional Conference on Africa's Environmental and Natural Resources Information and Management Needs, to be organized in cooperation with the Government of Senegal and held at Dakar from 25 to 29 October 1993;

(i) A United Nations Workshop on the Use of Space Techniques for Monitoring and Control of Desert Environments, to be organized in cooperation with the Government of the Syrian Arab Republic and held at Damascus from 14 to 18 November 1993;

(j) A United Nations Regional Training Course on Remote Sensing Applications to Geological Sciences, to be organized in cooperation with the Governments of Nepal and Germany and held at Kathmandu from 20 September to 13 October 1993.

87. It should be noted that the number of activities being organized in 1993 is substantially higher than usual and represents a level of activity that cannot

be sustained within the existing resources. None the less, it is indicative of the increasing needs of the developing countries and the increasing interest of developed and developing countries in supporting and hosting United Nations activities in the field of space technology and applications.

88. The coming years will see further rapid development in space technology for environmental monitoring and sustainable development, with the launching of new satellites and the development of new data-processing techniques and new applications. In order to respond to the needs of developing countries for more information and education on those developments, support from host countries and supporting countries and organizations for the Programme on Space Applications will need to be continued and increased. An increase in Programme activities will also require an increase in personnel for the Office for Outer Space Affairs, a requirement that could be met either from the regular budget or through voluntary contributions from Member States.

89. An increase in the level of activities in the Programme on Space Applications relating to environmental monitoring and sustainable development would constitute a substantial contribution to the implementation of the recommendations of Agenda 21 in specific applications areas as well as in general areas such as promoting science for sustainable development (chap. 35), promoting education and training (chap. 36) and providing information for decision-making (chap. 40).

2. Fellowships for advanced education

90. Following UNISPACE 82 and in accordance with its recommendations, the Programme on Space Applications substantially increased the number of fellowships available through the Programme for long-term, in-depth training for scientists, technologists and educators from developing countries. In recent years, however, the number of fellowships has remained stable or declined. These fellowships are sponsored and funded by host Governments and institutions and do not have any funding from the regular budget. For 1992-1993, the Governments of Austria, Brazil and China and the European Space Agency are offering a total of 19 fellowships through the Programme.

91. An increase in the number of fellowships available for advanced study in the applications of space technology, including environmental remote sensing, data processing and the use of geographic information systems, is essential for meeting the objectives set forth in Agenda 21. This requirement might best be met through increased voluntary contributions from Member States and organizations with expertise in those areas, but an allocation of some money for that purpose from the regular budget would enable the United Nations to better meet the specific requirements of individual developing countries as they arise. Financial resources that would enable the Programme on Space Applications to share some of the costs of fellowships would make it easier for the Programme to solicit fellowships from institutions with expertise.

3. Technical advisory services

92. The Programme provides, in accordance with the recommendations of UNISPACE 82 and on request from Member States, technical advisory services to developing countries, particularly in the areas of programme planning and regional cooperation. Examples of such services include assistance to the Governments of Costa Rica and Chile in the organization of the first and second Space Conference of the Americas, cooperation with ESA in providing remote-sensing data from ESA ground stations to countries in Africa covered by those stations, technical advice in the development of remote-sensing pilot projects for the Indian Ocean Marine Affairs Cooperation (IOMAC) programme and consultations with Member States within coverage range of the ground receiving station at Cotopaxi, Ecuador, in order to promote full regional use of that facility. The Programme is prepared to conduct further missions at the request of Member States to provide technical advice on the application of space technology for environmental monitoring and sustainable development policies.

93. An increase in technical advisory services in the field of space applications could be an important contribution to the implementation of the recommendations of Agenda 21. A substantial increase in this area could be made possible through voluntary contributions to the Programme on Space Applications in the form of expert consultants available for technical missions to developing countries.

4. Centres for space science and technology education

94. The General Assembly has repeatedly stated, most recently in resolution 47/67 of 14 December 1992 (para. 9 (c)), that it is particularly urgent to implement the UNISPACE 82 recommendation that the United Nations should support the creation of adequate training centres at the regional level. Since 1985, the Programme on Space Applications has been developing a proposal for regional centres for space science and technology education in developing countries as part of its efforts to promote the development of indigenous capabilities in space technology and applications.

95. Three regional meetings, in Africa, Asia and Latin America, and one international meeting were organized to consider how to promote the education of educators and the integration of space technology and applications into relevant educational disciplines. The participants at these meetings concluded that in order for the developing countries to contribute effectively to the solution of global, regional and national environmental and resource management problems, there is an urgent need for a higher level of knowledge and expertise by educators as well as by research and application scientists in developing countries. These capabilities, they further noted, can only be acquired through long-term intensive education.

96. While many students, educators and researchers from developing countries now go to developed countries for advanced training and research, such programmes are very expensive and can only accommodate a very limited number of people. A small number of developing countries are developing national educational programmes relating to space technology and applications, but most countries are not yet in a position to do so. The opportunities for appropriate

advanced education at affordable cost for people from developing countries could be substantially expanded through the establishment of regional educational programmes in developing countries that have the capability to support such programmes. The emphasis of the centres on educating educators will provide a multiplier effect to ensure a long-term, adequate supply of trained specialists in the various disciplines required for sustainable development.

97. The proposal for the establishment of regional centres for space science and technology education was endorsed in 1990 by the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space, by the Committee itself and by the General Assembly. Consultations have been held with interested countries in the developing regions and with developed countries that might support the centres. Evaluation missions have been undertaken to potential host countries for such centres in Latin America and Africa, and efforts are being made to organize a mission for Asia and the Pacific. Consultations are continuing to consider how best to establish the centres and ensure their long-term viability in meeting the needs of the countries of each region.

98. In the initial phase, the centres will concentrate on advanced education, research and applications development programmes in remote sensing, satellite meteorology and geographic information systems. Improving data processing and information management capabilities in developing countries, including archives of satellite data and links to international environmental databases, such as the Global Resource Information Database (GRID) of the United Nations Environment Programme, will be an important element of the centres' functions. The centres will therefore make a major contribution to meeting the need identified in Agenda 21 to develop the capacities of developing countries to participate effectively in the global effort to protect the environment and ensure the sustainable development of all countries.

99. The establishment of the regional centres will require a strong commitment of support from the host countries as well as technical and financial assistance from developed countries or international organizations. Such assistance could take the form of full- or part-time technical specialists, data-processing equipment and software, satellite data, funding for scholarships and other human, technical and financial resources.

B. International Space Information Service

100. UNISPACE 82 recommended that an International Space Information Service be established within the Office for Outer Space Affairs and that it should initially consist of a directory of sources of information and data services that would be made available to all countries.

101. As part of this effort the Office has published and periodically updated two directories of information relating to space activities. A Directory of Education, Training, Research and Fellowship Opportunities in Space Science and Technology and its Applications was first published in 1986 (A/AC.105/366 and Add.1 and 2), an updated edition was published in 1989 (A/AC.105/432 and Add.1) and a third edition is now being prepared. A Directory of Information Systems on Space Science and Technology was first published in 1988 (A/AC.105/397), a

revised edition was issued in 1988 (A/AC.105/397/Rev.1 and Add.1) and an expanded and updated version was published in 1992 (A/AC.105/517). The Office has also periodically prepared a document entitled Space Activities of the United Nations and International Organizations, describing the organization and activities of space-related programmes of the United Nations, the specialized agencies and other international organizations. The most recent edition of that document was published in 1992 (A/AC.105/521).

102. In recent years, the annual session of the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space has included a symposium on recent developments in a selected area of space technology and applications organized by the Committee on Space Research (COSPAR) of the International Council of Scientific Unions (ICSU) and the International Astronautical Federation (IAF), and Member States have arranged for other special technical presentations. A number of these symposia and presentations have addressed issues relating to the environment and development. In order to make that information widely available, the Office has prepared each year a summary of the presentations and distributed it to the Committee and to other interested groups. The symposia and other presentations focused particularly on environmental applications of space technology in 1989 (A/AC.105/431) and 1992 (A/AC.105/516).

103. The workshops and seminars organized as part of the Programme on Space Applications have included many papers describing practical applications of space technology in developing countries. In order to make those papers more widely available, the Office for Outer Space Affairs has prepared an annual publication entitled "Seminars of the United Nations Programme on Space Applications", containing selected papers from the activities organized that year. The most recent volume in that series is document A/AC.105/532. A major purpose of this series of publications is to improve the exchange of information between developing countries, as recommended by UNISPACE 82.

104. In accordance with UNISPACE 82 recommendations, and at the direction of the Scientific and Technical Subcommittee, the Office for Outer Space Affairs has prepared a series of technical studies on specific space technologies and applications. Among the studies relevant to Agenda 21 are a study on applications of space technology to flood monitoring and control (A/AC.105/472), a review of upper atmosphere studies for weather and environment monitoring (A/AC.105/477), a study on the applications of space technology for integrated land and water resources management for rural development (A/AC.105/490), a study on applications of space technology to the study of desertification in developing countries (A/AC.105/501) and a study on the applications of space technology for ocean resources applications (A/AC.105/535). Studies on the applications of space technology to forest resources management and to sustainable development are currently under way, as requested by the Scientific and Technical Subcommittee. The Committee could request the Subcommittee to consider what further applications of space technology relating to the environment and development could be subjects for future studies.

105. A priority for the further development of the International Space Information Service is the development of computer links to external electronic information networks and databases. Due to a general lack of financial resources, the Office has not been able to implement that aspect of a space

information service. Voluntary contributions of computer terminals and access to international space-related databases, or funding for such systems and services, would improve the ability of the Office for Outer Space Affairs to respond to requests for information from Member States relating to environmental space data and technical information.

C. Coordinating environmental space activities

106. The Office for Outer Space Affairs works closely with other international organizations with space-related activities. Within the United Nations systems, the Office conducts cooperative activities with FAO, UNEP, WMO, the International Telecommunication Union (ITU) and the United Nations Educational, Scientific and Cultural Organization (UNESCO). The Office for Outer Space Affairs also cooperates extensively with IAF, COSPAR and the European Space Agency, as well as with the International Telecommunications Satellite Organization (INTELSAT), the International Maritime Satellite Organization (INMARSAT), the International Society for Photogrammetry and Remote Sensing (ISPRS) and a number of other international organizations. ESA, INTELSAT, INMARSAT, the International Organization of Space Communications (INTERSPUTNIK), the Council on International Cooperation in the Study and Utilizations of Outer Space (INTERCOSMOS), ISPRS, IAF, COSPAR, and the International Law Association (ILA) have observer status with the Committee and provide the Committee with reports on their activities and programmes. Most of the activities of the United Nations Programme on Space Applications are organized in cooperation with one or more of those agencies and organizations.

107. The agencies of the United Nations system concerned with space meet annually at the Inter-agency Meeting on Outer Space to exchange information on their programmes and to plan cooperative activities. Based on that meeting, a report entitled "Coordination of outer space activities within the United Nations system" is submitted annually to the Scientific and Technical Subcommittee, most recently in document A/AC.105/524.

108. Outside the United Nations system, the Space Agency Forum for International Space Year (SAFISY) was formed in 1988 to coordinate activities and plan cooperative projects for International Space Year 1992. Under the theme of "Mission to Planet Earth", the activities of International Space Year focused largely on environmental monitoring from space. SAFISY consisted of 29 national space agencies, with the United Nations Office for Outer Space Affairs as an associate member. With the end of International Space Year, the members of SAFISY will continue many of its projects and functions through the continuing Space Agency Forum (SAF). The Committee and its Member States might consider how it could support the work of SAF and broaden participation in projects initiated or coordinated through that organization.

109. The coordination of United Nations activities for the implementation of Agenda 21 will be carried out primarily by the new Commission on Sustainable Development. The Office for Outer Space Affairs will brief the Commission on its work and that of the Committee on the Peaceful Uses of Outer Space, and the Committee may wish to submit the present report, together with any comments it may have, to the Commission. The Office for Outer Space Affairs and the

Committee should continue to follow the work of the Commission and keep it informed of relevant developments in space technology and applications.

D. Policy-making for the space environment

110. While Agenda 21 focuses on the Earth environment, it also recommends that relevant organs and organizations of the United Nations systems, in cooperation with other international governmental, intergovernmental and non-governmental organizations, should use a suitable set of indicators related to areas outside of national jurisdiction, such as the upper atmosphere and outer space (para. 40.7). The Committee on the Peaceful Uses of Outer Space has, since its establishment, considered the question of the protection of the space environment. Provisions to that end have been included in the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies of 1967 and in the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies of 1979. In 1992, the General Assembly, on the basis of the work done by the Committee, adopted the Principles Relevant to the Use of Nuclear Power Sources in Outer Space (resolution 47/68 of 14 December 1992), as a further measure to protect the space and Earth environment.

111. The question of space debris is now being raised in the Committee and there is agreement that space debris could be a subject for in-depth discussion by the Committee in the future. A study on the environmental effects of space activities with particular emphasis on space debris, prepared by COSPAR and IAF at the request of the Scientific and Technical Subcommittee, is contained in document A/AC.105/420, and information submitted by Member States on the subject of space debris and the safety of space nuclear power sources, in response to a request from the General Assembly, is contained in documents A/AC.105/510 and Add.1, 2 and 3, and A/AC.105/542 and Add.1 and 2. The Committee might wish to consider what further action it might take in the development of international policy to protect the space environment.

E. Bilateral, regional and multilateral cooperation

112. In addition to the action that could be taken through the Committee on the Peaceful Uses of Outer Space and the Office for Outer Space Affairs, Member States of the Committee could also take action on their own, bilaterally or multilaterally, to implement the Agenda 21 programmes.

1. Planning and coordination of environmental satellites

113. A number of Member States with space capabilities are currently operating satellites with applications for environmental monitoring and sustainable development, and those and other States are developing new systems specifically designed for environmental applications. Based on the experience of previous satellites and their applications, and taking into account the recommendations in Agenda 21, Member States could plan, design and operate follow-on satellites so as to continue and improve the existing services that have proved valuable and to develop new systems to meet needs not currently being met.

114. Member States in the Committee on the Peaceful Uses of Outer Space have emphasized the importance of continuity and complementarity in remote sensing and meteorological satellite programmes. As an increasing number of States invest in ground receiving stations, it is important that those investments not be rendered obsolete by incompatible new technologies. The primary international mechanism for coordinating the planning of satellites with environmental applications and the compatibility of data formats is the Committee on Earth Observation Satellites (CEOS). CEOS has been working to increase the dialogue between satellite planners and users, including international user organizations, which now have affiliate status in CEOS, particularly with respect to environmental applications. The Committee on the Peaceful Uses of Outer Space and its member States might consider how they might promote the coordination of satellite systems and the dialogue between satellite operators and users through CEOS.

2. Facilitating access to data

115. Practical and financial difficulties in getting access to satellite data for environmental purposes has been a factor limiting the use of satellite data in many countries, particularly the developing countries, and member States of the Committee on the Peaceful Uses of Outer Space have expressed concern over high prices. Some actions have been taken to develop flexible pricing arrangements, including lower prices for research use, for educational use and for archival data. Arrangements are also being made to facilitate acquisition of data through networks of local agents and through access to index and browse facilities. The Committee may wish to consider how it can encourage those and other arrangements for making satellite data accessible to a wide range of users in all countries at affordable prices.

3. Pilot applications projects

116. An important means for promoting the use of space technology for environmental and other applications is pilot projects that develop and demonstrate methods for operational use of space data for practical environmental and developmental purposes. When such methods can be demonstrated to be operationally effective and to generate economic or environmental benefits, they can be transferred to other countries facing similar problems. While such practical demonstrations are often best conducted as part of national environmental and resource management activities, they can greatly benefit from international technical assistance. Regional organizations can assist in supporting such activities and in promoting the exchange of information on successful operational applications.

117. Such pilot applications projects can be promoted and supported by international organizations, including the Committee on the Peaceful Uses of Outer Space, the specialized agencies, IAF, COSPAR, the Space Agency Forum and others. The Committee and its member States might consider how they could best promote such pilot projects and ensure wide dissemination of their results. Member States might consider submitting such projects to the Global Environment Facility (GEF) and to the UNDP Capacity 21 programme for funding.

4. Information

118. In order to assist in providing all Member States with information on future plans for satellite systems with environmental applications, States members of the Committee could be requested to provide the Committee, as part of their annual reports, with more detailed information on such systems and access to data. The Office for Outer Space Affairs could be requested to prepare and periodically update a list of current and planned satellite systems with environmental applications, together with information on access to data.

5. Technical assistance

119. Developing countries continue to face difficulties in developing applications of space technology for environmental monitoring and sustainable development. Member States could assist such countries by providing technical assistance in the form of data, equipment and software for data reception, processing and analysis, expert consultants and technical literature and documentation. Developing countries could also be invited to participate in the design and construction of sensors and other subsystems for future satellite systems and in experimental environmental application projects.

Notes

1/ Official Records of the General Assembly, Forty-seventh Session, Supplement No. 20 (A/47/20, para. 103).

2/ United Nations publication, Sales No. E.93.I.8.

3/ Report of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space, Vienna, 9-21 August 1982 (A/CONF.101/10 and Corr.1 and 2), para. 430.